

Constructing Worlds

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**Constructing Worlds: Reflections on
science, technology and democracy**

Constructing Worlds

Reflections on science, technology and democracy¹

Wiebe E. Bijker,
Valedictory Lecture, Maastricht University
12 May 2017

"We are living in a technological culture." That was the summary of my inaugural lecture in 1995. Today I want to move from the question how to *study* our technological cultures to the question how we *construct* them. In a few big steps I shall take you from the social construction of technology to constructing socio-technical worlds. And finally, to the constructing worlds—the institutions, in which this construction work takes place.

The starting point for science, technology & society studies (STS), especially in the Netherlands and Scandinavia, was an engagement with societal issues in the 1970s and 1980s such as nuclear energy, the nuclear arms race and genetic modification. From the 1980s onwards, an 'academic detour' resulted in what now is an emerging if not booming discipline. The thrust of this academic detour into research and teaching was constructivistic. Scientific facts are not dis-covered by taking away the cover of nature and picking up the facts. Rather, scientific facts are constructed in social processes in the laboratory, the seminar room, the journal's editorial office, and the lecture hall. In a similar move, some of us then argued that also technology is socially constructed. Not in the trivial way that machines are designed and manufactured by people, but in the sense that the *working* of a machine results from social processes and not from physics, chemistry or mechanics.

Let me briefly illustrate this with an example. Let's talk about biogas, in India. The first time I heard about this biogas was as a potential solution to a huge problem that twice a year occurs in northern India. Farmers burn the rice straw that is left on the fields after harvesting, and a thick layer of smoke covers the foothills of the Himalayas and northern India, including India's capital New Delhi. The smoke is not only causing traffic jams in the capital, it is also polluting the environment and it is toxic for farmers and citizens. A new chemical treatment of that rice straw now promised to make it fit for producing biogas. With that biogas, electricity would be produced and that could in turn benefit the farming communities—everyone happy! Well, not quite: when we analysed the social construction of this biogas, a more complex picture emerged.

We identified different relevant social groups and mapped what biogas meant for each of them. And rather than one 'biogas', a whole range of different 'biogases' emerged. I'll mention a few now; the others you can read about in the extended version of this lecture.

For most farmers, the burning of rice straw is not a problem—it is a solution. Since the Green Revolution, farmers in Punjab have been charged with the

¹ This is the abbreviated version of the valedictory lecture as read on May 12th, 2017, in the St. Janskerk, Maastricht. For video recordings, see: <http://www.maastrichtsts.nl/bijker-farewell>. The full version of this valedictory lecture is published in the journal *Engaging Science, Technology and Society*, see: <http://estsjournal.org/article/view/170/96>

responsibility “to feed the nation” and been pushed to produce up to four crops per year. After harvesting the rice, they have only three weeks to clear their fields and prepare for sowing wheat. Most of the farmers do not see another solution but burning the straw. For them biogas would not be a solution, but an extra burden: collecting the straw from the fields, storing it, and transporting it to a biogas plant just costs too much labour, money and time. And additionally, Punjab villages typically have enough electricity anyway. So this is the first biogas—a non-issue, a ‘no biogas’.

The second biogas we see when we use the perspective of organic farmers: for them, biogas is part of a solution—but the solution to a very different problem. Their problem is not primarily the smoke, but that burning the straw destroys important nutrients, which they would like to give back to the soil. However, rice straw cannot be ploughed directly back into the soil. It first needs composting, and feeding it into a biogas plant would help: a biogas plant produces waste that can be used as organic fertilizer. So, for these farmers biogas is not a solution to the smoke, nor a non-issue: it is a ‘fertilizer-producing biogas.’

A third and very different relevant social group is the Ministry of Petroleum and Natural Gas. Their mission is to make India more energy-secure and to meet the international CO₂-emission agreements. A very ambitious biofuel program has been started which mostly builds on producing second-generation ethanol. Since a few months also biogas is gaining importance again. So, through the eyes of this ministry we see the ‘biogas for energy security’.

Using the biogas case, I now can briefly summarize the core concepts of SCOT, or the Social Construction of Technology. SCOT shows how a technology results from interactions between social groups. I demonstrated the ‘interpretative flexibility’ of biogas: there is not one biogas but at least three different ones. The next question is then: what happens to this interpretative flexibility, which of these different biogases wins? I shall return to this question later.

Let me now continue with my historical sketch of STS. In the late 1990s some in STS began to argue that we had learned enough during our academic detour to return to the societal challenges—my inaugural lecture was part of that move. This implied several lines of work.

The first line relates to expertise. STS has shown that scientific facts are socially constructed. Does that imply that there is nothing special about scientific expertise? Can we do without science just as well? No, we cannot. Our technological cultures are so thoroughly permeated by science and technology, that it would be silly to think so. Yes, early STS work in the 1970s demonstrated that “science is human work”, but that was to counter the almost priest-like status of scientists in society, which made them immune to critique and democratic governance. These days, many STS-ers find themselves underlining the valuable character of scientific knowledge. For us, in STS, there is of course no contradiction: scientific knowledge still is socially constructed, but we also show that this social construction yields knowledge of a particular kind and special value.

As a brief intermezzo: what, then, is so special about scientific facts? In a world in which ‘alternative facts’ figure so prominently these days, it is tempting to overstress the objectivity and certainty of scientific facts, but then we would be falling back into the pitfall of quasi objectivity—a pitfall out of which we have been climbing since the 1970s. I have no better answer than the following: scientific and scholarly facts are produced and validated by a complex institutional machinery, culturing specific values—the scientific community with its unwritten rules, scientific

methodologies, peer review, etc. This does give scientific facts a special quality, but it does not imply that there cannot be uncertainty, or that it is impossible that next year we will conclude that a particular statement is false, which today we still consider a true fact. It also shows that controversy between scientists is normal and no reason to lose trust in science.

How can citizens and policy makers make sense of scientific facts, especially if scientists are still not in agreement? A distinction that Harry Collins introduced is very helpful. Citizens and politicians only need 'interactional' expertise—the expertise to interact with scientists. They do *not* need 'contributory' expertise—the expertise to contribute new scientific knowledge. Thus, policy makers and citizens without scientific training can also discuss questions about the use of science and technology in society.

An example that this indeed does work can be found in the Netherlands National Dialogue on Nanotechnology. The Dutch government decided to have “a societal dialogue on the social and ethical aspects of nanotechnology”—and to do this even in an early stage of the development of nanoscience. With this decision, the government followed the advice of the Gezondheidsraad. The results of this 2-year dialogue process, involving thousands of citizens and stakeholders, were the following: a small but significant increase in understanding of nanotechnologies, a small but significant increase in recognizing that nanotechnology involves risks, and finally an increase in support for continued nano research. I draw two conclusions from this experiment. First, that citizens are not afraid of new science and technology, but that they are afraid of governments, scientists and industrialists who do not tell them everything, including the negatives. Second, that it is possible to discuss such complex scientific issues with citizens and stakeholders who are not trained in that specific science—who have only interactional and no contributory expertise.

In the past two decades, we have seen a change in the social contract between science and society. The reasoning now is: our societies are confronted by grand challenges—health, food, sustainability, climate change, security—and we want science and technology to help us address these. The Dutch National Research Agenda (NWA) is an example.

In this NWA experiment, everyone in the Netherlands was invited to submit questions to science. Citizens, NGOs, municipalities, businesses—together they generated more than 11,000 questions. These were then filtered and validated by the Royal Netherlands Academy of Arts and Sciences (KNAW). Some questions were filtered out—for example because they were impossible to research scientifically. My favourite example of such a question is: “Does life after death exist, and can we commercialize it?” A complex institutional machinery, including scientific review and stakeholder conferences, processed the remaining questions into a National Research Agenda and a Science Investment Agenda for the new government.

My second example of society steering research is the Dutch research funding agency NWO, and particularly two recent changes in its practice and structure. The first change was the inclusion of the top-sector policy of the Ministry of Economics in the NWO practice. Whatever one may think of the top-sector policy in general (for example, that it is too nationalistic and too narrowly economic—but those were political choices), I do think that NWO succeeded to develop a set of practices to manage research funding under this topsector scheme, which allowed societal shaping of research without jeopardizing the scientific quality of it.

Responsible Research and Innovation is one such program to which I shall return below.

The second way in which NWO adapted itself to allow more influence of society on science was its recent transition into a different organizational form. The new NWO comprises of only four disciplinary domains and a few cross-disciplinary Steering Groups. Let me use *WOTRO/Science for Global Development* as an example. The research funded by WOTRO aims at contributing to the UN Sustainable Development Goals and to inclusive global development. A broad range of societal partners—from the Ministry of Foreign Affairs to NGOs such as ICCO, HIVOS and CORDAID—can approach WOTRO with research questions and funding possibilities. WOTRO will then coordinate with the relevant NWO domains to organise the funding.

Research funded by WOTRO raises questions about the relations between science, technology and development. One way to rethink development agendas and the role of science and technology therein, is to put vulnerability of technological cultures centre stage. In doing so, STS researchers have added the cultural to the societal, *Gemeinschaft* to *Gesellschaft*, solidarity to security, precaution to prevention, and justice to legality. They argue that more attention to ethics and justice needs to complement current styles of governance and policymaking. This broadening has direct implications for development and intervention. More intervention points become visible, and more intervention strategies become available.

Let me return to our current biogas project in India. I have introduced SCOT as a research heuristic: by identifying the relevant social groups, I could demonstrate the interpretative flexibility of biogas. Using SCOT, however, also means that one is making an intervention. Such intervention is often *inevitable*. But intervention can also be *deliberate and planned*, as is often the case in development research. Identifying new social groups and giving them a platform may, for example, change the discourse and even the power balance between social groups. Our symmetrical analysis of biogas thus pushed us to help the organic farmers to explicate their views on biogas. This made our research better, but it also empowered the farmers and was thus an intervention into the sociotechnical ensemble of rice straw and biogas, beyond research.

Does this mean that we are not only *studying* the social construction of biogas, but that our interventions also actively *contribute* to that social construction? But what mandate do we have, as researchers? Where to draw the line between understanding and intervening, between research and development? Or is such a line not possible and should we rethink the character of scientific research? Programmes of 'Responsible Research and Innovation' (or RRI) underline the importance of such a rethinking exercise.

RRI programmes explicitly seek to translate societal challenges into research goals and questions. Our biogas project is such an RRI project. RRI aims at a more responsible development and use of science and technology in society, at technology and research that have "the right impacts".

Being alerted by RRI's raising of normative questions, we could identify even more biogases than the ones I reviewed previously. There is, for example, also a 'holy biogas'. This is a by-product from the cow since cow dung has the best bacteria to break-up rice straw. This harks back to ideas of local sustainability and recycling where nothing is 'waste', at a time when cows were part of every household, treated as almost part of the family and loved and prayed to. This is

proper, solid farmers' knowledge, but it is now being hijacked by Hindu-religious groups who thus see biogas as a way of reviving the glorious past of a Hindu India, while having the benefits of enough fuel in their present socio-technological world.

So, here we are: researching and intervening—studying biogas and intervening in Indian society by asking RRI-type questions. What to do with this double identity? In our interventionist role, we are just one social group amongst the others. There is nothing special about us if it is about *intervening* in society. But now I have a problem, since as researchers we do have a special role. Scientific facts have a special and precious status when compared to alternative facts. And I do want to contribute to maintaining that status and, where needed, restoring the status of and the trust in science.

Talking of trust, what does the previous analysis of the role of researchers as also interventionists imply for our democracies? I do not join the chorus of lamenting that there is not enough trust in science. Research by the Rathenau Institute and the Netherlands Scientific Council for Government Policy (WRR) has shown that Dutch citizens still trust scientists—at least much more so than that they trust politicians and journalists. Trust, however, needs to be symmetrical. Yes, society should trust science; but science should trust society too. And that is exactly what RRI asks us to do: to take social groups in society seriously, to listen to stakeholders' views about risks and benefits of knowledge and innovation. Trust also comes in tandem with control—with regulation, review, protocols. Trust is also—like control—shaped by the constructing worlds, the institutional machineries that I am focussing on.

Let me return to biogas, for the last time. How will that story end? Which worlds will be constructed, which of these will win? Will it be the 'holy biogas', surfing on Narendra Modi's Hindu-populist and violent nationalism; or the 'energy-security biogas' as spurred by international relations; or the 'fertilizer-producing biogas' of the organic farmers; or will we stay with the current 'no biogas'? Asking which of these worlds will win the construction struggle is asking which of the groups can push its knowledge, values, interests most. But is this the kind of democracy that we want? A fight about who is strongest in constructing his world? Remember our vulnerability analysis: then a different set of criteria for democracy lights up. These are about community, justice, precaution, solidarity; and about plurality, variability, creativity. They are about global inclusivity, sustainable development, and guarding fundamental human and ecological rights.

Is this romantic daydreaming? Not necessarily so. This is not only a moral argument; we need not depend only on people doing good. One way of summarizing three decades of STS work is to emphasize the complex social processes and institutional machineries that construct scientific knowledge and that make the quality of democracy: back-stage processes in Dutch advisory councils, as well as Indian NGO practices to organize creative dissent. The way these machineries and practices are organized is, of course, not innocent: they will promote certain values and frustrate others, depending on how exactly they are shaped.

So, this will be the challenge for our final biogas conference in September. To devise mechanisms of deliberation, fact checking, learning, consensus building, accepting differences, so that groups can see that things could indeed be otherwise than in their own limited perspective. To engage them in constructing a world that solves the problems of rice-straw burning, but also farmers' livelihoods, ecological sustainability, India's energy provision, and industries' economic stability? Here,

research and intervention will come together: we will present our findings, but not as a scientific dictate that prescribes one solution; we will also intervene by creating platforms to make the social groups interact with each other in novel ways and thus generate new solutions that no one may yet have seen.

This exemplifies the fundamental question that I have been talking about today without once mentioning it clearly. How can we make science accountable to society *and* make it work—make it function in our democracies *and* let it produce scientific knowledge? How can researchers give all relevant social groups their due *and* play their own role as scholars?

And: How can a Dutchman recognize the differences in power—between West and East, between white and brown, between male and female, between academic and not formally trained—and take his responsibility to act in the world and contribute to constructing a better one?

My friend and colleague Trevor Pinch always says: try to make only one point in a presentation, and you'll probably end up making two. So, my take-home message for today is twofold: one about societal institutions and the second about personal style.

First message: to construct a world for the next generations, that can cope with the grand challenges that we face and do this in democracy and without war, we need to invest in our societal institutions, in the constructing worlds, in the machineries of democratic deliberation and knowledge production—advisory councils, peer review, high-quality journalism, public dialogues, open source science, a strong civil society, scholarly ethics review, etc.

Second message: whether we are researchers, activists or citizens, we all need to combine confidence in our own expertise with modesty when listening to others who speak from another expertise—let's cherish a style of 'bold modesty.'

To begin the last part of this lecture, in which I want to thank colleagues and friends with whom I have worked these past 30 years in Maastricht, I must start by mentioning what is possibly the most important intervention that any academic can have: teaching students. Certainly in Maastricht, this is very much a collective endeavour. I am deeply grateful to all colleagues of the Faculty of Arts and Social Sciences with whom I have been doing this exciting and so rewarding intervention towards constructing a better world. There is only time to mention here a few from these very many. It feels weird to address you in English; on the other hand: this is where the personal and the professional do overlap. As a compromise, I have read the remainder of the lecture in Dutch, but publish it here in English.

There is only time to mention a few from the very many with whom I have collaborated in teaching: Anique Hommels in the bachelor and master programs CWS, Jessica Mesman in the European master ESST, Karin Bijsterveld in the research master CAST, Sally Wyatt and —again—Karin in WTMC.

The other side of teaching is learning, and not only by students. In my inaugural lecture I said "that eventually it is the teacher who learns most." I can now report to you that at least on that point I have been right. I cherish the memory of my joint learning with students that so much forms the *raison d'être* of all universities, of these institutions, these constructing worlds.

This constructing world could not exist without the crucial support staff that really make the machinery tick. Sanne Winckens and Merle Achten helped me to acquire and manage externally funded projects; Bureau Onderwijs offered me much more help over the years than what I deserved; and then of course the secretariat

with Jacqueline, Dianne and Sabine. Sabine Kuipers has been helping me for some 25 years and I will not tell you of all the instances which would have turned out disastrous without her preventive and repairing work.

With Wiel Kusters I share warm memories of the early days of administering our faculty and its precursor, but also of adventuring into mining history and poetry. Rein de Wilde has been a colleague and friend ever since Gerard de Vries brought us here. His importance for me personally and for the faculty cannot be captured in footnotes or acknowledgements. Sophie Vanhoonacker has been a great support, especially in the last few years—as friendly and kind as she is determined and strategic.

I am very happy that Harro van Lente has been appointed professor of Science & Technology Studies. I am grateful for the generosity of the University Board and the Faculty Board who allowed Harro to be appointed already in 2014, which made for a very smooth and effective transition of most of my roles.

Now, finally, about my daughters and about Tonny. I shall not chicken out, as I did in my inaugural lecture, by hiding behind some clever formula. Let me be more explicit this last public occasion.

Of course, I enjoyed working with Liselotte on her history of medicine, reflecting with Else on her malaria trials, presenting with Sanne at the Oerol festival after her Cello8tet-Amsterdam performances—but the real treasure has been to see three such strong women construct their lives so beautifully—I have learned more through and from the three of you than a father could hope for.

Talking of strong women. Tonny, you have been more important in my work life than you probably know. I would, for instance, not have ended up in India or engaged with handloom weaving without your input. More importantly —because spanning more than 40-years— has been your critical commitment and incisive social intuition, which supported and guided me at crucial moments. For me, you are an honorary STS-er, though I realize that you will not be impressed at all by that title. I am deeply grateful to you.

This lecture was about constructing worlds, about using STS to make a better world for next generations. I cannot dedicate this lecture to all the children of this world—that would really be too pretentious. Instead, I dedicate this lecture to our two grandsons Waldemar and Tristan.

Mevrouw de Rector, ik heb gezegd.